A New Reference Quality Equation of State for Ethane

D. Bücker and W. Wagner [C, S]
Lehrstuhl für Thermodynamik, Ruhr-Universität Bochum, Bochum, Germany

A new formulation for the thermodynamic properties of ethane in the form of a fundamental equation explicit in the Helmholtz energy is presented. The functional form of the residual part was developed using state-of-the-art linear and nonlinear optimization algorithms. It contains 44 coefficients which were fitted to selected data of the following properties: thermal properties of the single phase and the vapor-liquid saturation curve, speeds of sound, isochoric and isobaric heat capacities, and second virial coefficients.

High precision data that redefine the pvT surface of gaseous, liquid, and supercritical ethane, including the vapor-liquid phase boundary have been measured recently in our group with single- and two-sinker apparatuses. Additionally, new measurements of the speed of sound in gaseous and supercritical ethane were performed by other groups using spherical resonators such that today the caloric as well as the thermal properties of fluid-phase ethane are known to a very high degree of accuracy.

The new equation of state describes the pvT surface of ethane with an uncertainty of less than ±0.02% to ±0.03% from the melting line up to temperatures of 520 K and pressures of 30 MPa. In the gaseous and supercritical region almost all high precision speed of sound data are represented to within less than ±0.015%. Other reliable data sets are represented within their experimental uncertainty. The primary data that the equation was fitted to cover the fluid region from the melting line to temperatures of 673 K and pressures of 900 MPa. Beyond this range the equation yields a reasonable extrapolation behavior up to very high temperatures and pressures.